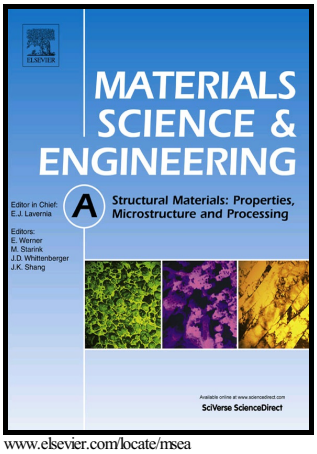
A detailed model of high pressure torsion

S. Khoddam



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S. Khoddam

Institute for Frontier Materials, Deakin University, GTP Building, 75 Pigdons Road, Waurn Ponds, VIC 3216, Australia
Corresponding author Phone: +61 3 5227 1102, Fax: 03 5227 1103, E-mail address: shahin@deakin.edu.au

ABSTRACT

High Pressure Torsion (HTP) is a popular physical simulator to produce ultra-fine grained materials. Existing solutions of HPT predict a zero deformation and grain refinement near its sample's longitudinal axis. However, experimental observations confirm that this is not typically the case. For a more realistic study of material's flow during the test, a detailed model was presented here in which the sample was represented as a "*Cylindrical Segment* (CS)" with a small run-out. A HPT-CS model was developed which included a parametric representation of the 3D problem and a kinematically admissible velocity field. The model was solved and the effective strain rate and strain for the problem were formulated. To verify the HPT-CS solution, a special case with zero run-out and two general case solutions (non-zero run-out) were compared with the existing solution of HPT as the reference. The sample comparisons confirmed the accuracy of the proposed solution. Distributions of effective strain rate and strain along the sample's longitudinal axis were presented for the general case solutions. These increased linearly from zero at the sample's mid-plane to their maximum at its top-plane. The maximum values for the second case were 0.138 s^{-1} and 0.290, respectively. An explanation for the grain refinement near the sample's centre was suggested based on the presented HPT-CS' solution.

Keywords: Severe Plastic Deformation; Parametric Representation; Closed-form Solution